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...Food and
Agricultural Sciences

1985 Accomplishments for Research, Extension, and Higher Education

A Report to the Secretary of Agriculture

The Joint Council on the Food and Agricultural Sciences was established in 1977 to encourage and coordinate research, extension, and higher education activities in the food and agricultural sciences. This role was strengthened in the Agriculture and Food Act of 1981, which directed the Department to improve the planning and coordination of research, extension, and higher education within the public and private sectors and to relate the federal budget process to the overall functioning of the system.

The Joint Council identified four reports which will work towards improving the overall effectiveness of the food and agricultural system.

A long-term **needs assessment** (20-30 years) for food, fiber, and forest products and the research, extension, and higher education requirements to meet the identified needs. (This task was assigned to the Secretary of Agriculture in the Agriculture and Food Act of 1981. He requested the Joint Council to fulfill this responsibility). The needs assessment report was prepared and published in two separate documents. One is the *Reference Document: Needs Assessment for Food and Agricultural Sciences* and the other is the *Summary: Needs Assessment for Food and Agricultural Sciences.*

A **five-year plan** to reflect the coordinated goals and objectives of the research, extension, and higher education community. This report was published in 1984 and will be updated biannually.

An **annual priorities report** on research, extension, and higher education, which presents the Joint Council's priorities for the next fiscal year, the required financial support, and suggested federal, state and private sector roles. This report will be completed by June 30 of each year.

An **annual accomplishment report** which specifies the ongoing research, extension, and higher education programs and respective accomplishments, along with expectations for the future. This report will be completed by November 30 of each year.

These four reports are inter-related although each is published separately. They constitute an overall strategic planning process which provides the food and agricultural science system with a means of assessing short-term and long-term future needs and reflecting on past accomplishments. They provide a foundation for planning the most effective and efficient means for meeting the future demands for food, fiber, and forest products. These four reports also offer a continuing mechanism by which the research, extension, and higher education programs can assess future needs.

The symbol appearing on the front cover represents the purpose of the Joint Council (i.e., to improve planning and coordination among research, extension, and higher education) and the cooperative character of the food and agricultural science system within federal, state, and private organizations.

Joint Council on Food and Agricultural Sciences

Secretariat:
Rm. 321 A, Admin. Bldg.
U.S. Department of Agriculture
Washington, D.C. 20250

November 30, 1985

Honorable John R. Block
Secretary of Agriculture
Washington, D.C. 20250

Dear Mr. Secretary:

The Joint Council on Food and Agricultural Sciences is required by Section 1407, Public Law 95-113 (as amended by Public Law 97-98) to submit to the Secretary of Agriculture an annual summary of ongoing research, extension, and teaching programs, accomplishments of those programs, and future expectations. We are pleased to submit the 1985 report to you.

This report of the past year's accomplishments of science and education in food and agriculture relates to the priorities identified by the Joint Council and to the goals enumerated in the Five-Year Plan. It also describes the contributions of research, extension, and higher education both to those directly involved in the food and agriculture system and to society in general. The report emphasizes the key role played by the agricultural science and education system in our Nation's progress.

This year's report contains a feature article entitled "Change, Choices, and Challenges" prepared by Dr. Sylvan Wittwer of Michigan State University. It also highlights about 50 key accomplishments selected from among more than two hundred submitted to the Joint Council by the National Agricultural Research Committee, the National Extension Committee and the National Higher Education Committee. A summary of the activities of the National Committees and Regional Councils of the Joint Council and a bibliography of recent planning studies conducted by several State institutions of higher education and by Federal agencies are also included.

We look forward to the opportunity of discussing this report with you.

Sincerely,

Orville G. Bentley

ORVILLE G. BENTLEY
Cochairman

James H. Anderson

JAMES H. ANDERSON
Cochairman

Enclosure

The Joint Council fosters coordination and planning in public and private research, extension, and teaching in the food and agricultural sciences.

1985 Accomplishments for Research, Extension, and Higher Education

A Report to the Secretary of Agriculture

December 1985

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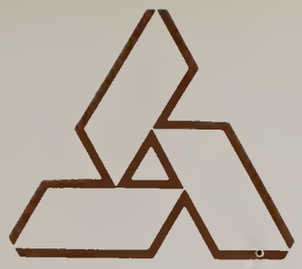

Executive Summary

A variety of programs and activities are conducted continuously in the diverse, multifaceted science and education system in food and agriculture. Many institutions and agencies publish annual progress reports describing how they have discharged responsibilities to their clientele. This publication, the 1985 Accomplishments Report, describes a few highly selective examples of progress and achievements of the many productive programs of the system. To obtain these reports, the National Committees (Research, Extension, and Higher Education) of the Joint Council solicited contributions from the several performing institutions and agencies. From the 223 examples submitted by 44 states and six federal agencies, the Joint Council chose fewer than 50 to highlight in this report.

Sensational scientific breakthroughs occur periodically and command the attention of the scientific community and the public. Of equal importance, but less publicized, are the consistent contributions of the many professors in science and education, who provide a solid academic background for budding scientists and professionals; the persistent and thorough researchers, who develop the basic framework for research progress; and the extension educators, who interpret and transmit new information to users so that it will be useful to society.

Change, Choices, and Challenges

Agricultural progress during the latter half of the 20th century has been phenomenal. The United States is witnessing a great agricultural revolution. The productivity of major commodities has increased twofold to fourfold during the past 40 years without an increase in cropland.

The choices and challenges for the Nation's agriculture are enormous, with far-reaching impacts on future research and educational programs and on both domestic and world societies. The tragedy is that hundreds of millions of people now suffer from food shortages and from malnutrition in a world that has, in total, more than enough to feed everyone.

Farmers face two major constraints to the adoption of new technologies. One is capital that is often needed; the other is managerial skills and education. The current trend in institutions of higher learning is toward specialization in such areas as biotechnology, computer science, econometrics, the environmental sciences, and nutritional biochemistry. All are narrowly focused and encouraged by competitive federal grants. The future challenge will be to integrate knowledge and put technology sets together so farmers with varying financial situations and skills can use them.

Cooperative Activities Among Functions, States, and/or Agencies

States and federal agencies frequently combine resources and expertise to attack problems on a broad front. Likewise, cooperation among research, extension, and teaching within and between states and/or federal agencies results in better service to clientele.

In 1985, the following cooperative activities contributed significantly to science and education in food and agriculture.

- USDA's Human Nutrition Information Service and a state cooperated to develop a Nutrition Education Information System (NUTREDFO).

- The Agricultural Research Service (ARS) and the Extension Service have developed a Research Results Data Base to provide for dissemination of current research findings.

- Various states have cooperated with ARS in developing a Germplasm Resources Information Network.

Professional Expertise Development

In nearly all of the priority-setting exercises in which the Joint Council and its Committees and Councils participate, the development of professional expertise ranks high.

The following programs and/or studies conducted during the past year merit special recognition:

- A task force of educators appointed by the National Academy of Sciences identified competencies needed by agricultural research scientists in the future.

- The National Needs Fellowship Program provided support for 302 graduate fellows at 47 universities in 35 states.

- Industry leaders assembled representatives from academia and Government in a "Forum for Excellence in the Food and Agricultural Sciences" to broaden public understanding of agriculture.

Natural Resources

Water use and management, soil productivity, and effective use of forests and rangelands are recognized areas of utmost importance. During the past year, professionals in science and education contributed to the understanding of several problems in these areas:

- Scientists contributed significantly to our knowledge of the effects of atmospheric deposition on water quality and on forest health, vigor, and growth.

- More efficient water-use methods were developed and extended in several states.

- Research and extension efforts have resulted in significant increases in the use of conservation tillage systems.

Crop Production and Protection

Crop scientists continue to use genetic engineering and other biotechnological approaches to improve the germplasm in economically important plants. Examples of advances in crop production and protection include the following:

- Scientists developed immunological methods that detect minute quantities of specific chemicals in plants, soil, and water.

- Researchers have cloned pathogen genes which interact with disease-resistance genes in soybeans.

- A combination of herbicides was found to be most effective in controlling leafy spurge, a noxious weed.

Animal Production and Protection

Improved molecular and cytogenetic techniques are enabling animal scientists to make substantial advances in biotechnology. Advances made during the previous year include development of:

- A new method of gene transfer permitting the viewing of nuclei in embryos shortly after fertilization.
- A method of bisecting bovine embryos, which, when compared to whole embryo transfer, improves reproductive efficiency.
- An automated system for monitoring antibodies that fight seven diseases in poultry.

Processing, Marketing, and Distribution

Food processing and distribution industries are the primary orchestrators of the food and fiber system, and significantly influence both agricultural producers and consumers. Several programs and studies in the past year have resulted in improvements in this area. Examples are:

- A cooperative Residue Avoidance Program to educate producers on how to avoid residues in meat and poultry.
- Development of methods that reduce energy requirements for drying products by 25 to 50 percent.
- Production of cotton fabrics with both durable-press and flame-retardant properties.

Agricultural Policy

The Joint Council Five-Year Plan states the need to develop a better understanding of how farmers, consumers, and others respond to market and policy institutions and to identify and provide for the information needs of those involved in the U.S. agricultural economy. Accomplishments in this area have included:

- An analysis of three new alternatives to commodity programs.
- A survey of some national farm and nonfarm organizations and agribusiness operators to ascertain their preferences for various programs in the 1985 farm bill.

People and Communities

Farm profitability is of great concern to the entire agricultural community. Farmers and ranchers need the benefit of programs on a sustaining basis to help them develop management approaches aimed at optimizing profit. Consumers need to know the role of nutrition in maintaining health. During the past year, significant progress was made on many programs related to people and communities.

- Extension helped farm families restructure their cash-flow situations and assisted them with financial management problems.

- Researchers found that diet control and exercise can reduce muscle breakdown in the elderly.
- Home horticulture and gardening programs drew more than 180,000 participants in 16 major cities.

Introduction

The United States is fortunate to have a unique system of agricultural research and education which has proven its ability to respond quickly and effectively to society's needs. It is a three-faceted system consisting of higher education, research, and extension of knowledge to the public.

One of the strengths of the U.S. food and agriculture science and education system is its diversity. Colleges and universities with curriculums in the food and agricultural sciences are found in every state. The **higher education** system includes community colleges, land-grant universities, other public universities and colleges, and privately financed institutions of higher education. Each has contributed in its own unique way to the enhancement of the productivity and efficiency of the food and agricultural system.

Research related to agricultural production and marketing is conducted by the state agricultural experiment stations of land-grant universities, by other public educational institutions, by various agencies of the Federal Government, and by private industry.

Research findings are transmitted to ultimate users by an **extension** education system unique to the United States. Because this extension system is organized at levels of government starting at the county level, it is indeed a grassroots organization.

In order to accomplish their goals and missions in the most thorough and efficient manner, most research and educational units in science and education develop long-range and short-range plans for the future. Planning involves efforts to forecast what will happen in a specific period of time and how best to organize and mobilize funds, facilities, and people to deal most effectively with the problems which are expected to arise and/or the technological advances which are needed.

The more diverse the organizational and geographic structure of an activity, the more difficult it is to control and coordinate. Yet coordination is important if scientific progress is to proceed at an optimum rate and problems are to be solved quickly and efficiently. Interdisciplinary and multidisciplinary approaches are often necessary if needed progress is to occur.

The Joint Council on the Food and Agricultural Sciences is the only national group which brings together both federal and state representatives from the three functional areas of science and education—research, extension, and teaching—for planning and coordinating activities.

A major role of the Joint Council is to monitor progress toward achieving national goals and objectives. The yardstick against which progress can be measured is found in the reports of the Joint Council: (1) the needs assessment report, published in 1984, which identified research, extension, and higher education requirements to meet identified needs for food, fiber, and forest products in the next 20 to 30 years; (2) the Five-Year Plan, also issued in 1984, which reflects the coordinated goals and objectives for research, extension, and higher education for a 5-year period; and (3) the annual Priorities Report, which identifies—for the purpose of budget development—the most urgent priorities of science and education in the food and agricultural system.

The keynote presentation in this report is the paper prepared by Dr. Sylvan H. Wittwer of Michigan State University entitled "Change, Choices, and Challenges." The subsequent sections provide information on progress being made toward achieving goals identified in

the Joint Council reports. Examples of accomplishments were solicited by the national committees of the Joint Council—the National Agricultural Research Committee, the National Extension Committee, and the National Higher Education Committee. A total of 223 examples were submitted from 44 states and 6 federal agencies. The Joint Council selected those which appear here as representative of the achievements of science and education during the past year.

The report also includes a summary of the activities of the Joint Council and each national committee and regional council. The appendix includes a listing of the fiscal year 1986 priorities (established in 1984 for use in developing the fiscal year 1986 budget) of the Joint Council (appendix 1) and a bibliography of planning studies (by states and agencies) pertinent to science and education (appendix 5).

Change, Choices, and Challenges[1]

Agriculture—the world's oldest, most dynamic, and most important industry—is in transition. Agriculture has been and remains the paradigm of modern science. The science of agriculture demands the inputs and coordination of all sciences, from physics and genetic engineering to sociology and anthropology. To be successful, modern farmers must apply, in a systematic approach, knowledge that emerges from scientific laboratories and field trials; be adept in natural resources management; adjust to labor supplies, automation, and changes in demand; acquire marketing skills; and have credit options. This is the challenge of contemporary agriculture.

Progress in agricultural development during the latter half of the 20th century has been phenomenal. We are now witnessing the greatest agricultural revolution of all time. One of the most remarkable features of American agriculture is a twofold to fourfold increase in productivity of major commodities during the past 40 years. This has been achieved without an overall increase in U.S. cropland, which has been stabilized at approximately 375 million acres since the early part of the 20th century. The greatest deviation from the norm occurred in 1983, when 83 million acres were removed from production because of drought and government programs. Therein lie the two most determinant factors in agricultural productivity: climate and politics.

The Production Dilemma

A decade ago, food shortages developed on a global scale. Some experts predicted that shortfalls in food supplies would remain commonplace and increase with time. All-out production was publicly advocated to meet diminishing reserves, the needs of rising population, greater export demands, improved purchasing powers, and desires for better diets.

Today, through economic incentives, commodity subsidies, an influx of new technologies, and a favorable climate, we have accumulated the greatest food surpluses the world has ever known. Some are now predicting a continuing age of glut. It has been suggested that we could feed all of our citizens using only half of our farmland. Within a decade, we have gone the full cycle from shortages, high prices, and low reserves to surpluses, overproduction, low prices, deteriorating farm incomes, and a crisis in farm credit.

The choices and challenges we now face for the Nation's agriculture are enormous, with far-reaching impacts on future research and educational programs and on both domestic and world societies. The tragedy is that hundreds of millions of people now suffer from food shortages and from malnutrition in a world that has, in total, more than enough to feed everyone. At no time in history has the fate of more starving and malnourished people, particularly in Africa and especially in Ethiopia, been more vividly portrayed to us via the media. This spectacle of too much food in some places and too little in others is especially shocking, since it is manmade. It has even been said that while half the people in the world are starving, the other half are dieting. To eliminate this inequity, to reinstate farming as a profitable business, and to keep food prices reasonable for everyone in a Nation that has enjoyed the world's lowest food costs for 50 years are among the greatest challenges we face. Abundant productivity has become both the blessing and the curse of American agriculture.

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[1]Prepared by Sylvan H. Wittwer, Director Emeritus, Agricultural Experiment Station, Michigan State University, East Lansing, Michigan.

Unique Endowments of American Agriculture

America has a wealth of **natural resources**, with a **climate** more favorable to food production than any other place on earth. The U.S. grain belts generally experience dependable temperatures and precipitation and are adapted to stable high production. A new record in crop production is being set in 1985. In the U.S.S.R., millions of acres of land are marginally cold and dry. China has frequent droughts in the north, with floods and tropical typhoons in the south. Failures in the monsoons are a common occurrence on the Indian subcontinent. Much of the world's population, particularly in Africa and the Middle East, live in small countries in the semiarid tropics, characterized by wide fluctuations in temperature and rainfall. Rapidly expanding populations and narrow geographical boundaries in most developing countries leave few resource options for agricultural production.

A unique **institutional network** characterizes the U.S. agricultural research and educational system. Components include county, state, and federal governments, with institutional inputs from land-grant and other universities and from industries. The system coordinates teaching, research, extension, and international programs in the land-grant university in each of the 50 states, and at Tuskegee University and the 16 colleges of 1890. The land-grant university system has been eminently successful, with accomplishments as yet unparalleled in other parts of the world. Attempts to emulate the system abroad have met with only partial success.

A vibrant **private or industrial sector** constitutes a third endowment of American agriculture. It equals or surpasses in magnitude the public support of agricultural research and development. Over 50 percent of the funding for agricultural research is from private industry. Most research in food science and technology is either conducted or sponsored by private industries. Major shifts from public to more privately supported research programs in the biological sciences, focusing on biotechnology, have occurred during the past 5 years. The private or industrial sector also has provided the infrastructure for vast developments in food processing and technology; for automation, mechanization, and farm machinery; and for supplies, credit, and trade.

A **free enterprise system**, which fosters the profit motive and provides economic incentives for farmers to produce, has characterized the American agricultural system. Such incentives are frequently lacking in the developing world and centrally controlled economies. With an attractive price, food will be produced.

Forces Changing American Agriculture

Many forces, some of which have not been experienced before, are affecting agriculture: Government programs, genetic engineering and other biotechnologies, mechanization and automation, on-farm personal computers and an accompanying communication revolution, changing patterns for agricultural exports and imports, an increasing number of part-time farmers and those with secondary incomes, and the transition of farming from a way of life to a business.

Societal trends are also affecting agriculture: increased disposable income; rising interest in physical fitness and increasing expenditures for "health," "natural," and "organic" foods; a "grazing society" with demands for "fast foods" and "eating on the run." Populations are aging, households are smaller, and there are more single parents. We now have new audiences of consumers with solitary eating habits and of two-income households. There is an increasing demand for freshness in fruits, vegetables, flowers, and fish. Dietary changes, based on perceived effect on health as well as cost considerations, are having

major impacts on some agricultural sectors. An example is the significant reduction in per capita consumption of beef, with parallel increases in marketing of broilers, turkeys, and fish. This transition is having a major effect on U.S. beef cattle producers, with cattle numbers dropping by 6 percent during the past 2 years.

The Natural Resource Base

Concerns about the resource base supporting agricultural productivity are reflected in changes that are occurring, or are projected to occur, in climate, land, water, energy, fertilizers, pest control, and the availability of genetic resources and human capital. There is a deluge of publications and reports—from conferences, committees, workshops, commissions, symposia, and individual authors—on issues of the adequacy, security, sustainability, safety, health aspects, strategic values, and dependability of our food supplies and agricultural productivity. New buzz words and phrases such as "sustainable," "regenerative," "alternative," "agro-ecological," "biological farming," "ecologically healthy systems," "holistic," "closed system agriculture," and "stewardship" have found a place in our vocabulary.

The present economic conditions and natural resource potentials provide a remarkable setting for positive action by the entire agricultural research and education community. With appropriate management, there will be adequate resources to meet both domestic and international demands well into the next century with little or no increase in food costs.

Some dramatic changes are occurring in the natural resource base, with potentially far-reaching impacts on agricultural productivity. There is currently a global buildup of atmospheric carbon dioxide, along with other "greenhouse gases" such as methane, carbon monoxide, and chloro-fluoro carbon trace gases. Because of their projected large-scale disruption of the global weather machine, these changes may have profound effects on the productivity of the U.S. breadbasket, the most powerful phenomenon on earth for producing food.

Thus, we are inadvertently conducting a great biological and physical experiment of global proportions, the outcome of which we do not know. This global buildup of atmospheric carbon dioxide may prove to be a boon to agricultural productivity through an increase in photosynthetic carbon dioxide fixation, greater water-use efficiency, a reduction in hazards from air pollutants, and an extension of the growing season.

Levels of air pollutants (ozone, sulfur dioxide, nitrogen dioxide) and acid depositions are increasing. The effects on agricultural productivity are regional and subtle in nature. They are multiple and they interact with manmade and environmental constraints and stresses.

Lands used to produce food and fiber crops in the United States and elsewhere are under stresses of soil erosion, salinization, deforestation, desertification, and conversions to nonagricultural uses. Neither the magnitude nor the rate of these changes and conversion is known; yet volumes have been published on the future hazards of some of the above practices and phenomena to the sustainability of our agricultural systems.

The management of water resources will be particularly critical for the productivity and dependability of food production in the decades ahead. It is estimated that U.S. agriculture now uses for irrigation 80 to 85 percent of all freshwater resources consumed—a far greater percentage than the Nation's energy budget for the total food

system. The current overdraft of ground-water resources, mostly for crop irrigation, is estimated at 20 to 25 million acre-feet per year. Many competitive uses for water (recreation, energy extraction, fish and wildlife reserves), other than for agriculture, have emerged. Some of those interested in boating and other forms of freshwater recreation have little concern about water quality for crop and livestock production.

Seldom has such a totally new set of competitive forces and manmade impacts been unleashed on air, land, and water resources. Yet a marvelous opportunity exists to take corrective measures to conserve, protect, and utilize these natural resources, since there is now massive overproduction and a surplus of almost everything produced in agriculture. There is also declining public support for farm subsidies and, alternatively, an ever-increasing support and demand for resource conservation. Alternative uses should be sought for highly erosive, fragile, and shallow cropland. Consideration should be given to diverting this land to other uses such as grazing, wood fuel production, reserves for wildlife, and recreation.

What agriculture needs more than anything else is water. The time has come to adopt water-conserving practices and computerized systems for crop irrigation. We must seek greater efficiency in fresh water use. In Israel, for example, water use efficiency is approaching 80 to 85 percent; this compares with the 35 to 40 percent now typical of America's agriculture. Drip irrigation is one approach which conserves water by irrigating the crop rather than the soil. Such measures would simultaneously conserve our soil, land, and water resources and bring agricultural production down to a level where prices will be profitable to the farmer and acceptable to the consumer. The challenge is for our agricultural leadership to merge the solution of the problem of overproduction with that of resource conservation. Posed is an unprecedented opportunity to meet the demands and hopes of conservationists and agro-ecologists and those who advocate a sustainable and ecologically stable agriculture.

With the increase of agricultural production no longer the immediate goal, the clarion call is for resource-sparing technologies and an evaluation of alternative systems of production. The research and educational challenges and priorities should now reside in soil, energy, and water conservation; greater resistance to environmental stresses; crop protection through integrated pest management and pesticide resistance management; biological nitrogen fixation; improved nutritional values of crop and livestock products; greater food safety and the protection of human health through genetic development of greater resilience to pests and diseases in both crops and livestock; and better raw product utilization through improved food processing technologies, storage, packaging, and distribution. These areas still offer unexplored horizons and provide exciting opportunities for creative agricultural research and educational programs.

The Capacity To Produce

What is needed is a research and educational program to design institutional arrangements, policies, and programs to prevent overuse of resources in times of surplus agricultural production and also to determine the need for public expenditures to offset the undesirable consequences of overuse. When agricultural production resources are overcommitted, society, as well as the farmer, loses.

Technology, of course, does not automatically expand production in periods of occasional shortages. For this to happen, appropriate institutions, infrastructures, and entrepreneurial skills must also be in place. If such a false premise is promulgated in periods of food

shortages and high food prices, it will also be believed in the much more common periods of surpluses, low prices, and overproduction, such as we are now experiencing. The obvious false conclusion will then be that production can be controlled by placing constraints on research and education and the generation of new technologies and utilization of the old.

In face of the above dilemmas of uncertainty and instability, the United States must seek increased production capacity, whether or not that capacity is actually used. All projections indicate that more science and technology must be put into agriculture to double crop production in the next half century. Food reserves and the reserve capacity to produce in time of regional or global conflicts and in the event of natural hazards are strategically important.

The capacity to produce and the use of such capacity are two different things, but the capacity must be at hand. New technologies and educational programs may or may not expand production in periods of shortages, and their use should not be suppressed nor support withdrawn in periods of surpluses. At the moment the United States is faced with surpluses of most all major crops and food animal products and of many minor ones. Furthermore, other major industries such as oil, steel, aluminum, copper, automobiles, tractors, wood, and timber are also seeking markets. A well-managed resource base of soil, water, energy, and air, combined with preservation of plant and animal genetic resources and the development of human capital, must accompany either an expansion or suppression of agricultural production.

A New Agenda and Challenges

The overall agenda for agricultural research, extension, and teaching is changing.

Farmers face two major constraints in the adoption of new technologies. One is capital; the other is managerial skills and education. The current trend in institutions of higher learning is toward specialization in such areas as biotechnology, computer science, econometrics, the environmental sciences, and nutritional biochemistry. All are narrowly focused and encouraged by competitive federal grants. The future challenge will be for publicly supported agencies to integrate knowledge and put technology sets together so farmers with varying financial situations and skills can use them.

The potential for using recombinant DNA and construction of plasmid vectors to genetically transform crops and livestock and to produce new biologicals and vaccines for disease control and growth promotion were just emerging 10 years ago. The rise of biotechnology corporations and centers is a novel feature of the past 5 years. The vision that the results of basic research may find immediate application has fueled the drive for profit in agricultural sectors previously emphasizing service. Independent agricultural consultants are beginning to fill a gap formerly occupied by publicly supported agricultural scientists and Extension specialists doing applied on-farm research. There have been major shifts from public to private support for programs. There is the burning hope that the scientific frontiers now being explored by representatives of both the public and the private sectors will become, in the words of D. E. Koshland, Jr., editor of *Science*, "so fascinating that making money may become incidental."

Accomplishments

Lest we forget the past accomplishments as we project change, choices, and challenges for the future, we are reminded of some of the contributions of joint efforts of state and federal governments, land-grant and other universities, and the industrial sector in research, extension, and teaching.

Conservation Tillage: This rapidly rising technology has been so named because it results in reduced soil, water, and energy losses. It is now effectively used on roughly one-third of U.S. cropland, up from less than one-tenth in 1972 when records began. Planting into the residue of previous crops without plowing the land can effectively reduce soil erosion on sloping land to almost zero, and at the same time greatly conserve soil moisture, energy, and organic matter. Conservation tillage is not yet widely used in other parts of the world.

Conservation tillage reduces soil and moisture loss

Integrated Pest Management (IPM): IPM is a philosophy and a set of technologies (cultural practices, biological controls, genetic resistance, chemical treatments) designed to control pests with minimal environmental and human health risks and costs to the producer. During the past 10 years, land-grant universities and USDA's Research and Extension Services have jointly participated in research and educational programs for IPM. In 1984, 8,420 pest scouts and 1,530 agricultural consultants were trained. As a result, over 75 million acres of U.S. cropland, rangeland, and forests were managed under IPM procedures.

Biological control of pests reduces environmental threat

New method developed for rapid forage quality evaluation

Rapid Assessment of Forage Quality: A new Near Infrared Reflectance Spectroscopic (NIRS) method provides almost instantaneous readings for the protein content of forages for livestock feeding. The system is portable and can be taken to places where hay is treated or being fed. This revolutionary method is an alternative to the laborious and time-consuming chemical analysis required before, and takes the guesswork out of forage evaluation for both buyers and sellers. The system was developed by USDA/ARS scientists working with state experiment stations. Forages provide more than half the food consumed by all U. S. livestock, two-thirds of the nutrients consumed by cattle, and one-fourth of the food ultimately consumed by Americans.

Dairy Herd Improvement: One of the most longstanding, comprehensive, sophisticated, and now computerized recordkeeping programs in the world is the National Cooperative Dairy Herd Improvement Program (NCDHIP). Beginning with 31 herds and 239 cows in 1906, it has grown to 63,800 herds and 4,630,000 cows in 1985—43 percent of U.S. dairy cattle. Since 1950, annual milk production per cow for herds enrolled has gone from 9,172 to 15,588 pounds. Gains have come from a combination of managerial skills and genetic improvements. Superior bulls selected from NCDHIP data have been used in artificial insemination. Superiority of U.S. dairy cattle is recognized worldwide and is a result of the combined efforts of participating dairy producers, with research and educational support from USDA's Agricultural Research and Extension Services and the land-grant universities and state Cooperative Extension Services.

Marek's disease vaccine saves poultry industry $200 million annually

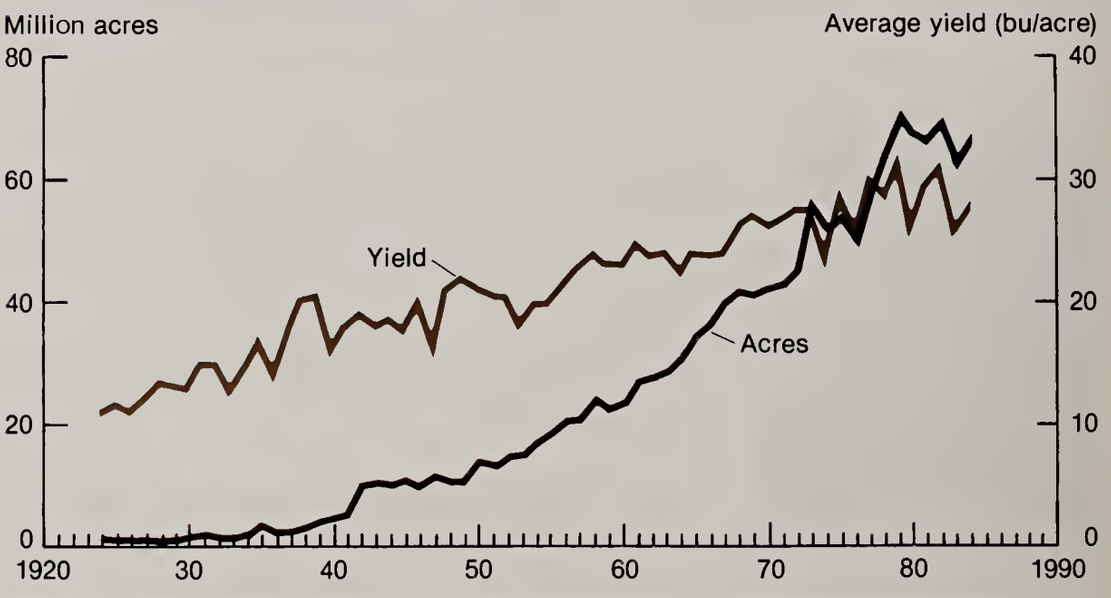
Control of Marek's Disease: Marek's disease, a tumor-inducing cancer in poultry, caused devastating worldwide poultry losses during the 1960's. A vaccine administered to chicks at hatching was developed and introduced by the Agricultural Research Service in 1971. This was the first control of a cancer disorder. In cooperation with state experiment stations, other research institutions, the Cooperative Extension Service, and private industry, the vaccine was rapidly accepted. Use of the vaccine has revolutionized the poultry industry and reduced disease incidences by as much as 95 percent. The estimated annual value of the vaccine in the United States alone for the poultry industry exceeds $200 million.

Pesticide Applicator Training Program: Over 2 million private and commercial applicators have been trained and certified since 1976 in the safe and economic use of pesticides. This remarkable training program, authorized by the Environmental Protection Agency and carried out under the leadership of the Cooperative Extension Service, provides standards and training materials, but makes state governments responsible for certification. The pesticide applicator training program has covered every state in the Nation. Because certain pesticides have been designated as restricted-use products which may be applied only by certified applicators, the training program has allowed the continued safe use of hard-to-replace pesticides which otherwise would have been cancelled.

Soybeans—the Cinderella crop

Soybeans, the Cinderella Crop: Soybeans, known as the "miracle bean" by the ancient Chinese and the "Cinderella crop" of America, were introduced into the United States from China as early as 1765, but received little attention until the late 19th century. They were of initial interest only as a hay crop and were highly regarded as "soil building" because they "fixed" nitrogen. Even by 1946, few Americans outside of relief agencies knew much about soybeans. Today the United States produces almost 2 billion bushels on 68 million acres, and exports about half of an 11-billion-dollar cash crop to supply 80 percent of the international market. Only through remarkable utilization technologies, involving both state and federal inputs and the private sector, has this been possible. Soybeans are primarily processed into oil for food and industrial uses and high-protein meal for livestock feeding. Production technologies have resulted in a doubling of yields during the past 50 years.

Estimated Annual U.S. Soybean Acreage and Average Yield of Beans, 1924–1984



Fat content of pork reduced

Improvement of Pork Quality: During the past 25 years, U.S. swine producers have applied new technologies resulting in significant improvements in high-quality meat-type hogs with half the amount of carcass fat. As a result, the average weight of market hogs has remained about the same—240 pounds—but the pounds of lard per 100 pounds of carcass have, since 1960, been reduced from 29 to 15 pounds.

Super Trees for Southern Pine Forests: For 30 years a quiet revolution has been going on in the Southern States, which have the Nation's largest timber resource of over 193 million acres. State foresters and the U.S. Forest Service have been cooperating in a Southern Pine Improvement Program. Genetically improved super trees, that grow 25 percent faster, are rapidly replacing the native or wild types. Most all pine seedlings planted are now genetically improved, and by 1995 all of those planted in the South will be "super trees," with growth rates of 35 to 45 percent above the wild types.

Genetically superior trees produced

Scientists identify lignin-degrading enzyme

Biotechnology and Microbiological Transformations: U.S. Forest Service researchers have isolated an enzyme that breaks down lignin, the natural plastic that cements and stiffens wood fibers. The enzyme is secreted by the fungus that causes white rot decay in wood. Lignin comprises 25 percent of wood. Next to cellulose, it is the most abundant organic compound on earth. This discovery opens the door to application of biotechnology in wood processing, biopulping, biobleaching, and converting lignin to useful chemicals. Biochemists in state agricultural experiment stations are demonstrating that this same fungus, and the enzymes from it, can be used as catalysts to degrade environmental pollutants, toxic substances, and industrial wastes and for on-farm chemical waste disposal units.

Food Quality Improvement: U.S. consumers can now have the assurance that foods are wholesome, safe, nutritious, palatable, and reasonably priced. This assurance starts with improved varieties, cultural practices, and raw products on the farm, followed by new handling, storage, and processing technologies. It ends with unique packaging, distribution, and marketing systems. Microwave heating and sterilization; aseptic processing and packaging of acid fluids, milk, soups, and stews; and dehydrofreezing of fruit to partially remove the water before freezing—all improve the quality and nutritional values, lower packaging costs, reduce expenditures for transportation, make American products more competitive, and open new world markets.

Human Resource Development: The greatest of assets are human resources. The generation of human capital, including agricultural leadership development, is the primary charge of the educational institutions of America. Agricultural and related colleges are the predominant producers of the graduates that are annually needed to fill the almost 60,000 national and international scientific, professional, and managerial positions in food and agriculture, natural resources, veterinary medicine, and related fields. Within such colleges, and under the same roof, there is a dynamic capacity to educate undergraduate and graduate students as an integral part of the teaching/research mission and the state/federal partnership. During the past 20 years, special agricultural leadership development programs have originated in at least 28 states as joint efforts between public and private sectors and foundations, with wide participation by farmers and agribusiness people. As a result, hundreds of agricultural leaders are now serving in local, statewide, and national capacities. At the federal level, a newly initiated postdoctoral research-associates program provides training opportunities to well-qualified bright young scientists to bring new ideas and skills into USDA's Agricultural Research Service.

Conclusion

We have the production capacity, the food security, and the resource capability to double U.S. agricultural production if need be, and to continue enjoying the world's lowest cost food. The concern should be whether, in the face of mounting surpluses, our leadership will see the importance of developing a capacity to produce, even in times of plenty, and to use this excess producing power to develop human resources and to conserve, protect, and manage our natural resource base for future agricultural productivity.

Cooperative Activities Among Functions, States, and/or Agencies

In numerous instances, the principal components of science and education—research, teaching, and extension—cooperate in a planned effort to reach a mutual goal. In addition, cooperation frequently occurs among federal agencies, among federal agencies and states, and among states. Several examples of shared efforts to attain a common goal are identified in this section.

Computerized Nutrition Guidance: Utah State University and USDA's Human Nutrition Information Center have developed a Nutrition Education Information System (NUTREDFO) designed for use by nutrition educators as a tool for nutrition guidance research and for development of nutrition guidance information. The data base contains three major files: (1) a permanent file of 460 foods and 26 nutrients or constituents, (2) a temporary nutrient file for user-stored nutrient values, and (3) a documentation file for on-line identification of the original source of each nutrient and constituent value.

Integrated Farming Systems: Decreasing prices relative to input costs, high interest rates, and the recent economic slump have forced producers to review their production, management, and marketing practices. Resources devoted to alleviating the profitability crisis have more than doubled in the past 2 years, with some states allocating 45 percent of their resources to this issue. While addressing this crisis on a short-term basis, the Extension Service also is implementing a multidisciplinary systems approach for the long term. A survey of 12 states indicates that 400,000 producers have received financial management guidance since January 1984.

Management models are helping producers deal with profitability problems. For example, agricultural producers, Extension specialists, and researchers now can use COFARM, a model developed by the Agricultural Research Service (ARS), to simulate the effects of alternate management practices on production and soil erosion. Also, Kansas has developed WHEATPRO, a microcomputer program for wheat farmers to help reduce risks associated with production and marketing.

Computerized Research Results Data Base: The Agricultural Research Service and the Extension Service have developed a Research Results Data Base which contains one-page descriptions of over 1,000 recent ARS discoveries ready for release to state Extension staffs. State Extension offices access the data base by computer terminal.

Fifty state Extension specialists tested the use of the data base during the past year and recommended making it available to all specialists. They also recommended that completed research from sources other than ARS be included. The data base will be made available to requesting specialists on a test basis through 1985 and to all specialists by 1986.

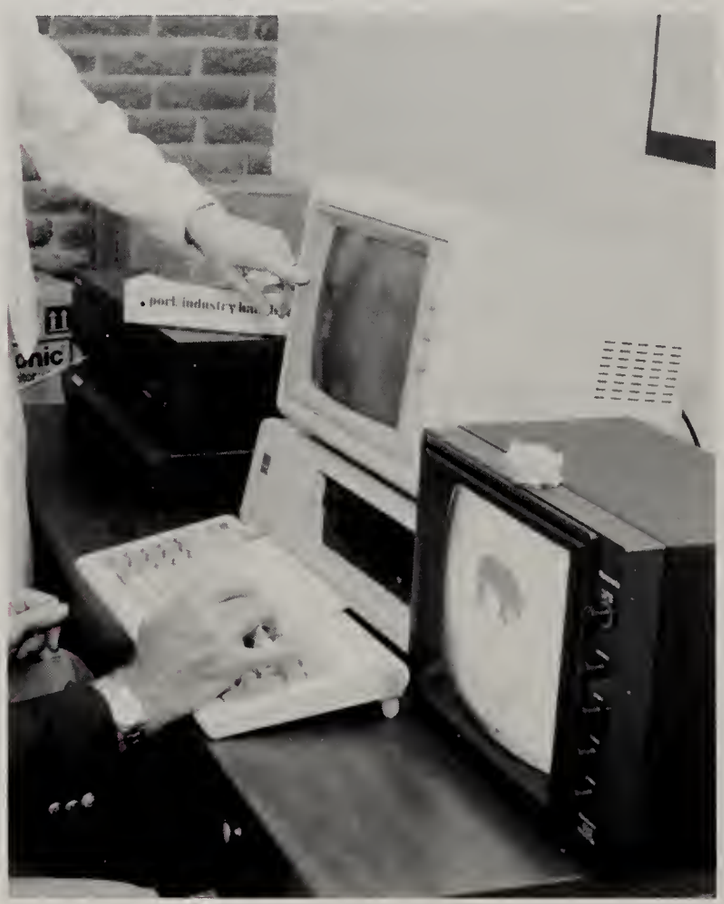
Plant Gene Expression Center: The Agricultural Research Service, the University of California at Berkeley, and the California Agricultural Experiment Station have jointly established the Plant Gene Expression Center (PGEC) at Albany, California. Research at the PGEC will focus on identifying the mechanisms that turn a given gene's activity on or off. The PGEC will assemble experts to unravel the complex biology of plant gene expression, stimulate and coordinate complementary research among public and private research groups, and ensure that the knowledge is quickly transferred. PGEC's mission is to convert fundamental research into new genetic tools to improve the yield and quality of crop plants and to render them resistant to insects, diseases, and environmental stresses.

Germplasm Resources Information Network: Information regarding the location, characteristics, and availability of germplasm accessions within the U.S. National Plant Germplasm System is now available to all scientists through the ARS-developed Germplasm Resources Information Network (GRIN). This computerized data base management system serves two broad groups of "information users": (1) the suppliers (such as curators and staff of the plant introduction stations) who acquire, maintain, and distribute germplasm and data; and (2) those who use the germplasm resources and data, including public and private plant breeders as well as other interested scientists and researchers.

Increasing Information Availability: The National Agricultural Library (NAL) is increasing the availability of agricultural information to all users. NAL has initiated cooperative arrangements for indexing of the agricultural journals and state publications held in land-grant institutional libraries and is incorporating this information into the AGRICOLA bibliographic data base. Inclusion of this information will make the titles in these libraries available nationally and internationally.

In addition to improved bibliographic information, NAL has improved its ability to provide textual information. The ability of NAL to provide translation services for foreign language articles on agricultural science and technology has broadened to include 19 languages.

The possibility of providing textual information electronically and online has been demonstrated by placing the *Pork Industry Handbook* on videodisc, thus allowing full-text electronic searching of the publication.



Pork industry handbook available electronically on-line

Professional Expertise Development

In both the fiscal year 1986 Priorities Report and the Five-Year Plan of the Joint Council, the importance of human resource development is emphasized. The 1984 Accomplishments Report states: "The most critical variable in the food equation today is the human capital which must continually strengthen and manage the highly technical and delicately integrated production, distribution, and marketing system." The National Higher Education Committee submitted 32 examples of important teaching and education-related accomplishments. The Joint Council selected a limited number for presentation in this section.

Assessment of Competencies Needed by Future Agricultural Scientists: The National Academy of Sciences (NAS) appointed a task force of educators and scientists to identify competencies needed by agricultural research scientists in the future. They also evaluated methods of forecasting needs for agricultural scientific expertise and proposed methods to meet changing demands. A 1985 NAS report articulates the competencies essential to provide a sound base of knowledge and insight for future professionals. A theme throughout the report is that future scientists will need a far broader range of competencies than in the past. The conclusions and recommendations challenge the state-federal partnership to advance the higher education system, particularly at the graduate level.

National Needs Fellowship Program develops young agricultural scientists

National Needs Fellowship Program: In 1984 USDA began a program to attract students into graduate study in the food and agricultural sciences. The National Needs Fellowship Program is an investment strategy to develop agricultural scientists and professionals in areas where shortages of expertise exist. The 67 proposals selected for funding in 1984 supported the first year of training for 302 graduate fellows at 47 colleges and universities in 35 states. In fiscal year 1985, Congress provided appropriations to continue this initiative. These funds supported the second year of graduate training for doctoral students in biotechnology (89), food and agricultural marketing (66), agricultural engineering (53), and food science/human nutrition (51). In addition, 43 master's degree students were supported.

Strengthening Food and Agricultural Sciences Higher Education: Industry leaders assembled a "Forum for Excellence in the Food and Agricultural Sciences." The forum invited representatives from academia and government to address issues related to recruitment of high-caliber students, faculty development, and curriculum enrichment. They identified the unidimensional image of agriculture (production) as a major factor inhibiting enrollment of science- and business-oriented students in food and agriculture degree programs. Hence, the forum committed itself to undertaking a national media campaign to broaden public understanding of agriculture as a scientific endeavor.

In addition, several U.S. corporations contributed funds to maintain an undergraduate agriculture and natural resources curriculum project initiated by USDA.

Agricultural leaders discuss recruitment of high-caliber students

Future Scientific Expertise: The declining number of high school graduates choosing agriculture as a career has severely affected enrollment in agricultural colleges. This has adversely affected both graduate programs and the agricultural industry. The colleges are addressing this problem in a variety of ways. In Virginia, for example, a mail campaign introduced agriculture to outstanding high school students. This was followed by a forum for science-oriented high school seniors. Students met with faculty in classes, at seminars, and informally. Wyoming used the magazine "Science of Food and Agriculture" to recruit outstanding students. In Louisiana, teams toured high schools to interest students in agricultural careers. North Carolina organized an agribusiness tour for high school counselors. The counselors reported a better appreciation of the science and technology of agriculture. Ohio prepared a slide/sound recruiting presentation and Georgia prepared an award-winning brochure, "Agriculture? You'd Be Surprised."

Program initiated to recruit outstanding high school students into agricultural careers

Minority 4-H members receive agricultural career awareness information

Agricultural Career Awareness Grants Program Initiated: This new grant program will award funds to land-grant universities for development of innovative agricultural career awareness materials and programs that target minority 4-H members ages 13 to 18. A review panel will evaluate proposals in accordance with criteria that relate to planning, end products, and ease of replication and implementation. The Agricultural Career Awareness Grants Program is one of the many 4-H programs arranged by the National 4-H Council in support of the Cooperative Extension Service.

Integrated Curriculum in Range Management/Livestock Production: Animal sciences curriculums focus on animal nutrition, physiology, breeding, and management, while range management curriculums are principally concerned with range ecology, management, planning, rehabilitation, and improvements. Many students have educational needs that are best met by an integration of these two disciplines.

At a workshop at Washington State University, participants discussed an integrated curriculum in range management and livestock production. Undergraduate curriculum options adopted by the Departments of Animal Sciences and Forestry and Range Management integrate principles of the two disciplines. They are combined with cooperative research activities between the two departments, using a forested range unit in north central Washington. The integrated curriculum is unique and addresses the need for a more realistic approach to range management and livestock production.

Integrated curriculums available in range management and livestock production

Training Young Leaders: The California Agricultural Leadership Program has been a successful, unique, and creative multiuniversity and agricultural industry initiative. Some 450 outstanding young California agricultural leaders have graduated from or are presently in the program. Four former participants are now members of the California Legislature, and the program has produced scores of other industry and community leaders. The cooperating universities are California State Polytechnic University at Pomona, California State Polytechnic University at San Luis Obispo, California State University at Fresno, and the University of California at Davis.

Natural Resources

Conservation and efficient use of our soil, water, forest, rangeland, and wildlife resources are of utmost importance to our national welfare. Sustaining soil productivity; efficient water management; and enhancing forest, range, and pastureland productivity were three of the top nine Joint Council priorities for fiscal year 1986. The Five-Year Plan emphasizes the negative effect of soil erosion on long-term productivity of agricultural lands. It also states that "the degradation of water and air quality can impact the future productivity of crops, ranges, forest and wildlife habitat." The Joint Council selected the following accomplishments from 34 nominations for inclusion in this report.

Atmospheric Deposition Research: Atmospheric deposition may be causing lakes and streams to become more acidic than normal and also may be contributing to reductions in forest health, vigor, and growth. Various studies summarized by the Forest Service in 1984 show that (1) nitrogen oxide emissions from the Los Angeles basin are a major source of dry acid deposition affecting nearby mountain watersheds; (2) microorganisms in the soil and forest floor in southern Appalachian forests convert precipitated sulfates into organic sulfur, immobilizing the sulfur and providing a buffer against the impacts of acidic precipitation; (3) acidification of some clearwater lakes in northern states is related to acidic precipitation; and (4) in some central Appalachian watersheds, plants and soil may be preventing stream acidification.

Atmospheric deposition may effect water quality and forest vigor

Pesticide Impact Assessment: Wisconsin Extension is working with research and regulatory agencies to secure data for defining and evaluating the benefits and risks of selected pesticides. This involves monitoring changes in use patterns and assessing their impacts. Field trials of registered pesticides and alternatives allow monitoring of possible impacts of registration changes, particularly the effects on ground-water contamination and drift.

These studies led to the development of new application procedures for aldicarb. The new procedures retained insecticidal benefits while significantly reducing leaching potential. The evaluation in commercial cole crops showed a 45-percent reduction in insecticide use.

Alternative Production Systems: Conservation tillage, including no-till and ecofallow systems, has been found to reduce soil erosion by up to 70 percent, conserve moisture, and increase yields per unit cost. As a result of efforts by research and extension, the Soil Conservation Service, and soil and water conservation districts, the popularity of conservation or ecofallow tillage has increased threefold, to over 97 million acres, over the past 10 years. For example, in untilled wheat stubble, where effective weed control from herbicides has been obtained, row crops such as sorghum can be grown successfully as a no-till crop for 2 years.

Improved Water Use Management: Extension programs to increase the efficiency of irrigation pumping plants and to measure the amounts of water applied can reduce pumping costs, water use, and leaching of agricultural chemicals. In Nebraska, such programs were used on 2.6 million acres and saved 19 million acre-inches of water, 44 million dollars' worth of energy, and 20 million dollars' worth of nitrogen fertilizer. The use of improved water management technology saved an estimated 500 million gallons of water and reduced frost protection costs by $1 million for citrus growers in Florida. Delaware corn growers saved $175,000 per year by irrigation scheduling. In a related area, programs in Arizona helped 10,000 water well owners comply with new state laws requiring the metering of water withdrawals.

Engineers use laser technology to study soil erosion

Laser Technology for Study of Soil Erosion: Agricultural engineers in Tennessee have developed circuitry and computer software to process rainfall data from a laser spectrometer interfaced with a computer. The system allows engineers to study how rainfall energy relates to soil particle detachment and removal from the soil mass. Increased understanding of the erosion process should aid in identifying soil management techniques and farming practices which protect soils from erosion, avoid reduced productivity, and reduce waterway pollution.

Proper management techniques and farming practices protect soil from erosion.

Improving Range Management Through Monitoring: In the past several years, range monitoring programs have become a principal information source for decisionmaking for many western ranchers and public land managers. Well-designed monitoring programs provide continuing information on how grazing animals are utilizing range resources, the impacts of climate and natural events, and the response of vegetation to both. Through careful analysis of these causes and effects, managers can make timely response decisions.

A monitoring workshop jointly sponsored by Extension and the Bureau of Land Management in 1982 greatly stimulated the implementation of monitoring programs in the western region. New draft policies and procedures were reviewed and revised, training needs were assessed, and cooperative program implementation plans were initiated. Since the workshop, strong cooperative monitoring programs have been developed in Arizona, Idaho, Nevada, Utah, and Wyoming, with Extension playing a major role.

Range resource utilization improved through monitoring

Crop Production and Protection

Improving the genetic potential of plants used for food (including grains, fruits, and vegetables) and/or fiber is essential to maintenance of production and marketing efficiency. The rapid development of genetic engineering techniques and the need for improved germplasm placed basic biotechnology research at the top of the fiscal year 1986 Joint Council priorities list. The development and use of improved crop production systems has frequently been emphasized in priority statements. The National Agricultural Research Committee and the National Extension Committee received 46 examples of accomplishments in this category.

Low-cost method of monitoring agricultural chemicals developed

Technique for Detecting Agricultural Chemicals: Development by the Agricultural Research Service of immunological methods that detect specific chemicals in plants, soil, and water at parts-per-trillion levels will permit many samples to be evaluated daily in a single laboratory. This technique will be valuable in research to understand both the mechanisms of action and the fate of chemicals. There is a need to know if chemical residues interfere with cropping practices and whether such residues are impairing our food supply, ground-water quality, or other components of the environment. This new method of analyzing materials will enable the implementation of a low-cost national monitoring program.

Multi-Adversity Resistant Cotton Strains: The Texas Multi-Adversity Resistant (MAR) Cotton Breeding Program represents an innovative, high-risk approach to genetic improvements in cotton by use of natural resistance mechanisms. The system selects for seed quality, slow germination, and resistance to bacterial blight and other pathogens. It also provides an indirect selection for genes conditioning resistance to other pests, improved earliness, and higher yield potentials.

Four genetically improved cotton hybrid pools have been developed and distributed. A succession of new cotton varieties—each superior to earlier releases in pest and stress resistance, potential yield, or lint quality—have been released. The MAR cottons have allowed farmers to double yields, with a reduction of insecticide usage.

Cloned Genes Aid Study of Soybean Disease Resistance: For the first time, researchers have cloned pathogen genes which determine specificity of the pathogen with a host plant. The genes have been molecularly cloned from bacterial pathogens which interact with disease-resistance genes present in soybeans. The bacterial genes are being characterized in collaborative work in California. Proteins are being isolated from various bacterial 'avirulence' genes. These will be assessed for affinity to the protein of disease-resistance genes. It is presumed that the cloned pathogen genes interact with the plant's resistance genes via primary or perhaps secondary gene products. The work may permit subsequent molecular cloning of the disease-resistance genes.

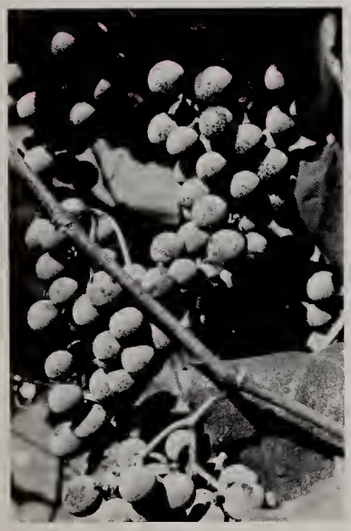
Biocontrol fungus reduces root rot in potatoes

ARS Patent for Biocontrol Fungus: The Agricultural Research Service has been issued a patent on its discovery and development of a fungus that destroys disease-causing fungi in crops. The beneficial fungus, *Trichoderma,* was obtained from soil, developed to improve its effectiveness, and shown to control root-rotting diseases of potatoes and vegetables in the field. The patent is the first on biological control of plant diseases and has been purchased by a private company.

Pollen Use in DNA Transfer: Researchers in Illinois recently developed a procedure in which segments of the genetic code of wild corn relatives are incorporated into the DNA of pollen of common corn inbreds. By using this incorporated pollen to pollinate standard inbreds, they are able to introduce unique characteristics, such as leaf rust resistance, into domestic hybrids in one or two generations, in contrast to the 8 to 15 generations required by conventional plant breeding techniques. An important advantage of this system of transferring genes is that individual traits can be transferred from a donor to a recipient genome in one generation without upsetting the equilibrium of the recipient genome.

Integrated Pest Management (IPM): The IPM program is a major contributor to Extension's efforts to increase agricultural profitability. Data from most states show a range of production cost savings of between $27 and $60 per acre. Several states also report yield increases of between 5 and 20 percent. Analysis of 1984 reports from the cotton programs in Arkansas, Louisiana, Mississippi, and Oklahoma indicate that growers' pesticide costs were lowered by over $18.5 million. In instances where production increases are an appropriate method of increasing profitability, IPM can help. For example, production of rice and vegetables in Puerto Rico increased 40 percent and 15 percent respectively for farmers who participated in the program.

Effective, Economic Control for Leafy Spurge: Leafy spurge, a noxious weed, infested over 861,000 acres in North Dakota in 1982, costing the state nearly $13 million in lost returns. Before 1982, the most widely used herbicide was 2,4-D, which did not reduce the infested acreage. Picloram, the most effective herbicide, was used sparingly because of its cost. A management study begun in 1980 found that an annual application combining picloram and 2,4-D was the most cost-effective treatment. This program should achieve approximately 80 percent leafy spurge control in 4 years and realize a net return of at least $42 per acre.



Cause of grape disease identified

Cause of Leaf Roll Disease Isolated: The virus causing leaf roll, the most widespread and economically important disease of grapevines, has been isolated in New York. This disease reduces fruit yield and quality of wine and increases the chance of winter injury to vines. The only available control has been to use vines which have been proven healthy by up to 2 years of testing. With isolation of the causal organism, antisera can be developed rapidly, reducing the amount of testing time from 2 years to 2 days with a subsequent reduction in cost of indexing from $200 to $2.

Plant Defense Mechanisms Studied: Wounding of plants generates cell wall fragments which are involved in sending distress signals. As a result, defensive chemical inhibitors are produced in entire plants, such as in tomato, tobacco, and alfalfa. Two research programs at Washington State University have enhanced the understanding of the role of fragments in the induction of synthesis of defensive chemicals. This could lead to the isolation of a gene control mechanism which can be used in many genetic engineering approaches. Furthermore, understanding of how these natural defense genes function could make it possible to engineer a plant that is naturally resistant to pests by introducing such genes into plants by genetic engineering.

Animal Production and Protection

Livestock and livestock products account for about half of the cash farm income in the United States (about $70 billion annually). Research and extension programs on animal production and protection are prominently mentioned in the priorities identified by National Committees and Regional Councils. Improving plant and animal efficiency (including protection) was ranked fifth (of nine) in the top priorities listed in the fiscal year 1986 Priorities Report. Opportunities exist for developing genetically superior farm animals and developing vaccines through the use of molecular genetic techniques. Some of the exciting work underway is described in this section.

Genetic engineering techniques for livestock improved

Improvements in Animal Breeding and Efficiency: Progress continues in the breeding and efficiency of animals, including improvement of animals through biotechnology or natural selection. For example, a new method of gene transfer permits the expanded use of superior livestock. The introduction of new genes depends on the ability to view nuclei in embryos shortly after fertilizaton. Until now, nuclei in cattle and swine embryos could not be seen without destroying them in the process. With the new method, cattle and swine embryos are centrifuged at over 15,000 times gravity, causing sedimentation of dense material in the ova and making the cell nuclei visible. The embryos are not damaged, and normal healthy pigs have been born after centrifuged embryos were transferred to surrogate mothers by ARS researchers. The ability to produce genetically engineered livestock will allow livestock breeders to significantly modify the genetic makeup of animals in one generation.

Two new strains of channel catfish have been developed and released by the Alabama Agricultural Experiment Station. Both grew faster than current wild strains and had improved disease resistance, or were easier to harvest by seine. The first-generation cross of the two new strains produced fish that were easy to catch with hook and line and that could be spawned reliably when 3 years old. The faster growing strains of fish are needed to satisfy the increasing demand for catfish.

New method developed for gene transfer

A year-round supply of hatching eggs is needed to have broiler production throughout the year. To maintain a continuous supply, egg-laying can be delayed by restricting the hours of light per day and then stimulated by increasing the light per day when hatching eggs are needed. Restricting light during the summer has been difficult because it also restricted ventilation necessary for cooling. Agricultural engineers with the North Carolina Agricultural Experiment Station developed a housing structure which blocks out light but permits ventilation fans to operate at full capacity. At a saving of over $1 per bird per cycle, the savings to the industry would translate to approximately $21 million per year in North Carolina.

New strains of faster growing catfish developed

Nonsurgical recovery of embryos from superior cows, bisection of the embryos, and transfer to less valuable cows to complete the pregnancy is now a growing practice. It increases the reproductive rate of superior cows tenfold. At Colorado State University, researchers developed a simple method of bisecting bovine embryos, transferring the demiembryos to recipient cows, and getting 50 percent more surviving calves than with whole embryos. The demiembryo technique produces identical twins, which are exceedingly valuable for research. Not only are fewer animals required, but unique experiments are now possible.

New Procedures To Detect and Prevent Livestock Diseases: Notable progress has been made in procedures to develop both testing systems to detect animal diseases and vaccines to provide immunity. Researchers at Pennsylvania State University have developed an automated system for monitoring antibodies that fight seven diseases in poultry. This system can perform large numbers of tests quickly and accurately at low cost. The devastating outbreak of avian influenza demonstrates the need for rapid, reliable means of assessing disease and immunity in poultry flocks. The Enzyme-Linked Immunosorbent Assay system (ELISA) uses computer-operated equipment to quantify antibodies in poultry. Researchers are developing a similar system for screening birds for avian influenza.

Vaccine against coccidiosis developed

A genetically engineered antigen developed by ARS scientists is the key to developing a vaccine against coccidiosis, a disease that costs the poultry industry $300 million a year. The coccidia parasites attack the intestinal tracts of chickens and turkeys. The antigen provides protection against clinical infection by the major species of coccidia. Disease-infected chickens that received the antigen grew faster than those that did not.

Monoclonal antibodies were used to isolate several antigens, which in turn were used by ARS scientists to develop a very sensitive diagnostic test for swine trichinosis. The test is of great value in field studies to identify infected herds for control. The antigens show promise as vaccines to prevent infection in young swine and in the development of improved drugs to treat trichinosis in swine and humans.

Sensitive diagnostic test developed for swine trichinosis

Processing, Marketing, and Distribution

The Joint Council Five-Year Plan states that processing, marketing, and distribution of food and fiber will become increasingly critical to maintaining national employment, controlling inflation, and improving balance of payments. The importance of this area is emphasized by the fact that the marketing system accounts for about three-fourths of the people employed in the production and marketing of foods and fibers. From the 32 reports of accomplishments received in this area, the Joint Council chose to highlight the following.

Consumers Benefit From Production and Protection Programs: A wide variety of research and extension programs benefit consumers. For example, American agriculture makes extensive use of pesticides, drugs, and chemicals to maintain a plentiful, wholesome, safe, and reasonably priced supply of food. In recent years, as improved analytical methods have revealed the presence of chemical residues in foods, particularly livestock products, concerns about food safety have increased. This increased concern has led to increased Government controls on the use of chemicals which leave residues.

Foods are wholesome, safe, nutritious, palatable and reasonably priced

The Extension Service and the Food Safety and Inspection Service established a cooperative Residue Avoidance Program to educate producers on how to avoid residues in meat and poultry. Since the program began in 1978, residue violations have been reduced by 72 percent and the latest data show that the average residue monitoring violations in livestock and poultry were reduced to 0.7 percent. Forty-nine separate educational projects in 32 states have been or are currently being conducted. The educational program has resulted in increased returns for livestock and poultry producers and increased consumer confidence in the Nation's supply of meat and poultry.

Food demand is related to a variety of economic and demographic factors. Slower population growth, an older population, more women in the work force, and Government food programs have shifted consumer preferences in favor of more processed products. An Economic Research Service (ERS) analysis revealed that higher income households buy more fruit, vegetable, and potato products than lower income households but buy fewer dried and canned products. Households in the Northeast, in central cities, and those made up of older persons buy more fruits, vegetables, and potatoes than do others. Recipients of food stamps buy more vegetables and potatoes but less fruit than nonrecipients. These findings have important implications for the type of foods produced, the processing and distribution sectors, and food prices.

Engineers at the University of California have developed methods that reduce energy requirements for drying products by 25 to 50 percent through better moisture measuring techniques, increased air circulation, and proper burner installation. As a result of efforts by Extension engineers, adoption of the new procedures has resulted in savings of annual fuel costs to California walnut farmers and prune dehydrators of $250,000 and $1.5 million, respectively.

Processing Methods Improve Product Acceptability: New and improved processing methods have given products more consumer appeal. Scientists at the Oklahoma Agricultural Experiment Station have shown that the consumption of Lactobacillus acidophilus, a microoorganism commonly used in milk products, reduces serum cholesterol. The acidophilus organism actively absorbed cholesterol during anaerobic growth in a medium containing bile, and this was confirmed by feeding trials. Researchers found that milk itself had significant cholesterol-lowering properties. When pigs on a high-cholesterol diet were given whey protein instead of soybean meal, serum cholesterol was reduced by 15 percent. Past criticism of milk and milk products for contributing to high cholesterol levels should be reevaluated.

Cotton with improved or unique qualities is being developed to counter the trend toward synthetic fibers. Until recently, it was impossible to produce cotton fabrics with both durable-press and flame-retardant properties. However, cross-linking agents found by ARS scientists are capable of facilitating both of these desirable qualities, adding to the versatility and consumer appeal of cotton.

New Uses for Agricultural Byproducts: Increased utilization of agricultural products is encouraged by expanded use of agricultural byproducts. Nebraska researchers have developed a corn-whey co-fermentation process which uses whey, a byproduct of the cheese industry, to boost the yield of ethanol per bushel of corn processed. The separate but simultaneous fermentation of the corn sugar and milk sugar results in a more rapid, complete, and efficient fermentation. The yield of the corn-whey process is 3.65 gallons of ethanol per bushel of corn processed versus 2.6 gallons per bushel of corn alone, resulting in a cost savings of 28 cents per gallon of ethanol produced. The significant cost reduction increases the demand for corn by increasing the competitiveness of ethanol from corn. It also increases the utilization of the vast quantities of whey which must be disposed of at great expense to the dairy industry. Enough whey is produced each year to make over 300 million gallons of anhydrous ethanol when combined with corn in the co-fermentation process.

Researchers at the Ohio Agricultural Research and Development Center developed a prototype fluidized bed combustor that burns corn cobs without pollution; delivers more than 60 percent of this fuel energy as clean, hot air; and eliminates the plugging problem in conventional furnaces. Twelve tons of corn cobs from 10 acres of corn would produce about as much energy as 980 gallons of fuel oil. The combustor also can burn shelled corn. A bushel of corn provides energy equivalent to that of 4.2 gallons of propane. Thus, with propane at 85 cents per gallon, the value of the heat energy in a bushel of corn is over $3.50. The combustor has the potential to render farmers energy self-sufficient.

Agricultural Policy

The Joint Council's Five-Year Plan states that appropriate policy can improve the economic well-being of consumers, farmers, and rural society. The fiscal year 1986 Priorities Report emphasizes the central role of the United States in world agricultural and forest product markets, and further states that the instability in prices for agricultural products creates an uncertain operating environment for farmers, timber producers, marketers, input suppliers, and consumers. This underscores the need for carefully developed policies.

Farm Policy Analysis: Researchers in the Economic Research Service provided background and analyses for the 1985 farm bill discussions. In addition to individual reports on major program commodities and farm legislation topics such as credit, trade, conservation, and land use, a major agricultural and food policy review and evaluation was published. Particular focus was given to the purpose of commodity programs and an economic assessment of their performance. The analysis indicates that farm policy discussions have broadened considerably and the farm bill must now encompass issues beyond the control of agriculture: (1) Events outside the realm of price- and income-support programs such as foreign exchange rates, international credit, and trade policies significantly affect the demand for U.S. exports. (2) In periods of surplus production, price- and income-support programs permit farm production to continue on marginal, erosive lands, thereby adding to current production levels, adding to off-farm pollution, and diminishing future productive capacity. (3) Credit assistance to agriculture at less than competitive rates encourages investments in farmland and improvements at times when constraints on these investments are needed. (4) Special tax provisions permitting cash accounting and the sheltering of income to future years to be taxed at the capital gains rates encourage investments at a time when less capital influx in agriculture is needed. These factors become an essential part of the emerging agenda of policy concerns.

Farmers, leaders of national farm and nonfarm organizations, and agribusiness operators were surveyed by researchers at the University of Illinois to ascertain their preferences for programs in the 1985 farm bill. There was substantial agreement, but it was evident that enough division existed to make an acceptable compromise difficult. The respondents generally supported some type of public policy to improve the level and stability of farm prices and incomes, to ensure stable food supplies, and to provide adequate food aid for the poor at home and abroad. However, they preferred lowering the price support and target price levels and curtailing the public costs of some of the previous programs.

People and Communities

This is a broad category which includes human nutrition and extension programs with youth and with farm and urban families. Human nutrition and factors related to it are consistently mentioned as a top priority of science and education in food and agriculture. The fiscal year 1986 Priorities Report states: "Consumers are increasingly conscious of the relationship between their health and the quality of their diets." The Priorities Report also establishes the need to know more about eating behavior, food quality, and the availability of food nutrients. The current economic plight of farmers and ranchers underscores the need for programs directed to farm family finances.

Diet Control To Improve Health: Much progress is being made in identifying dietary changes that lead to better health. Physical work capacity, muscle mass, and rates of protein turnover are reduced with age. Older adults have a lower rate of muscle formation than younger adults and their muscles contribute less to whole-body protein turnover. ARS scientists have found that the rate of breakdown of muscle protein depends on exercise and hormones. Diet control and exercise can reduce the rate of muscle breakdown in the elderly, leading to more functional capacity, reduction in the percentage of body fat, and preservation of muscle mass during aging.

One study showed that a moderate reduction of fat in the diet lowered both systolic and diastolic blood pressure among males. In another ARS study, both blood pressure and serum cholesterol were lowered when dietary fat was reduced to 25 percent of total dietary calories and the ratio of polyunsaturated to saturated fats was adjusted to 1 to 1. These studies with high-risk populations confirm that both fat level and fat type affect blood pressure.

Added dietary chromium may help prevent diabetes and low blood sugar and lead to improved glucose tolerance. In an ARS study, exercise-induced increases in glucose utilization in male joggers were accompanied by a significant increase in chromium mobilization and subsequent urinary excretion. Adding chromium to the diet of elderly people improved glucose metabolism, suggesting that inadequate dietary chromium intake may be a factor in suboptimal health.

ARS scientists determined how three major minerals in the body (calcium, phosphorus, and magnesium) are affected by (1) a customary self-selected diet consumed by 21- to 52-year-old adults and (2) the level of dietary protein. Calcium and magnesium intakes, especially for women, are generally below the RDA; phosphorus and protein intakes are generally higher than recommended. The dietary protein level of individuals adversely affects calcium, phosphorus, and magnesium balances of women 35 years and over only. This depressive effect of protein on calcium balance affects bone metabolism and contributes to bone fractures in postmenopausal women whose bone density is below a critical level before menopause.

Extension agents provide management guidance to farmers

Extension Programs for Rural and Urban Families: A wide array of Extension education benefits both rural and urban families. "The Family Farm Crisis—Coping With Stress" programs, for example, are designed to help farm families deal with the stress resulting from the financial crisis threatening many farms. In Iowa, a team approach was used to multiply assistance to financially distressed farm families on financial management, stress-related issues, and even therapeutic intervention. Included were several training seminars for clergy, bankers, and lawyers who provide support for farm families at risk. In North Dakota, Extension helped farm families restructure their cash flow plans, and in more serious cases helped examine alternative employment opportunities. Michigan developed a four-phase program to help distressed farm families maintain the family—not just the farm.

Financially distressed farm families counseled

Off-farm employment important income source for many farm families

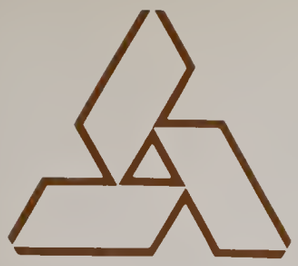
Southern University (Louisiana), recently completed a study showing that off-farm employment was a source of income for the majority of farm families and that farming becomes a secondary occupation for some farm families. Off-farm employment is an important source of income in the rural economy of Louisiana. Average off-farm incomes ranged from $17,457 for farm operators to $11,214 for spouses. The farm operator commutes a daily average of 20 miles, compared to 10 miles by the spouse. The study provides more information about off-farm opportunities for Louisiana farmers.

Cooperative Extension Service assisted by 2.9 million volunteers

Volunteers make a substantial contribution to Extension educational programs. A typical county Extension agent spends one-third of his or her time recruiting, training, and working with volunteers. However, each day that an agent devotes to volunteers generates 51 days of volunteer activities. An ongoing study showed that in 1983 the Cooperative Extension Service worked with 2.9 million volunteers who, in turn, reached 48 million different people directly. The value of their contributed time was $4.5 billion, almost 5 times the total amount of dollars contributed by federal, state, and local governments combined. Most volunteers work within existing Extension programs, but about one-fourth work with other organizations or as independent volunteers. Most volunteers teach and share information with others. Over half work as officers, members of advisory groups, or in other capacities in local organizations. About one-fifth work on community projects.

About 70 million American households engage in some lawn or garden activity; 17 percent of these households get reliable information directly from county Extension agents. Master Gardeners (trained volunteers) meet the needs of home horticulturists in 44 states. Extension also trains garden center and related personnel, and distributes educational information to the public through garden centers and other commercial businesses. Extension home horticultural and gardening programs in 16 major cities drew more than 180,000 participants (including 40,000 youth) in 1984. Assisted by an Extension staff of 165, augmented by 2,300 volunteers, these gardeners produced more than 20 million dollars' worth of food for home use. Other benefits to participants include lower food costs, improved diets and nutrition, vocational training, and increased community pride.

Master Gardener volunteers meet the needs of home horticulturists



Accomplishments of the Joint Council, National Committees, and Regional Councils

Joint Council on Food and Agricultural Sciences

Use of the Needs Assessment and Five-Year Plan: The Needs Assessment[1] and the Five-Year Plan for the Food and Agricultural Sciences[2] have both received extensive use by deans, directors, program leaders, and other decisionmakers throughout the food and agricultural science and education system. Considerable interest also continues from Congress, non-USDA federal agencies, private industry, and other associated organizations. The documents provide a useful vehicle for planning and evaluating progress within the food and agricultural system. The Five-Year Plan is being updated for submission to the Secretary of Agriculture in February 1986.

Fiscal Year 1987 National Priorities Published: Through a process that began in September 1984, the National Committees and Regional Councils of the Joint Council selected and ranked priorities for research, extension, and higher education. Using these state, regional, and national perspectives, the Joint Council selected and ranked five national priorities for fiscal year 1987. The priorities submitted to the Secretary of Agriculture were:

1. Increase Agricultural Profitability Through Management
2. Improve Water Quality and Management
3. Expand Biotechnology Efforts on Plants, Animals, and Microbes
4. Develop Necessary Scientific and Professional Human Capital
5. Improve Human Nutrition and Understanding of Diet/Health Relationship

Major Issues/Topics Considered: Several issues and topics were given special attention by the Council during the past year. They include:

- International cooperation/coordination—The Council passed a four-part resolution recommending improved coordination and cooperation among organizations/institutions with respect to international development activities. Followup actions are being coordinated with the International Science and Education Council, the Resident Instruction Committee on Organization and Policy, and the American Association of State Colleges of Agriculture and Renewable Resources.

- Agricultural Profitability/Competitiveness—Recommendations were developed during a joint meeting with the Users Advisory Board in November 1984 for improving the efficiency, the competitive position, and the profitability of agriculture through research, extension, and higher education.

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[1]Summary: Needs Assessment for the Food and Agricultural Sciences. A Report to the Congress from the Secretary of Agriculture. Joint Council on Food and Agricultural Sciences, USDA, Washington, D.C., January 1984.

[2]Five-Year Plan for the Food and Agricultural Sciences. A Report to the Secretary of Agriculture. Joint Council on Food and Agricultural Sciences, USDA, Washington, D.C., May 1984.

- Rangeland Resources and Management—The Council discussed the extent, diversity, and multiple-use values of the world's rangeland resources, and the contributions these lands make to the food supply and quality of life of both the United States and the world. They identified opportunities for the science and educational system to contribute to the management of rangeland resources.

- Issues Affecting Science and Education Priorities—Important issues that affect research, extension, and higher education programs in the food and agricultural sciences were presented by a series of knowledgeable speakers. The issues were related to the Council's priority-setting and planning activities, especially the development of the fiscal year 1987 priorities. Eight major issues identified were:

  1. Competitiveness in world markets
  2. Farm profitability
  3. Biological advances
  4. Impact of technology on farm size
  5. Diet/health considerations
  6. Interdependency of rural communities and agriculture
  7. Natural resources/environmental concerns
  8. Training professionals/administrators for the future.

National Agricultural Research Committee

During the year, the National Agricultural Research Committee developed a list of 16 research priorities requiring additional attention. That list represented a consolidation of four other priority lists—one from each of the four U.S. regions. In addition, every member research agency made a 5-year projection of its research program. As those projections were combined by geographical subregions and regions, numerous trends in research programs emerged. Basic research, biotechnology, soil and water conservation, and human nutrition were areas of expanding research nationally. Sensor-robotic high technology and integrated production practices relying on expert systems also were seen as future goals.

The committee studied the role of research units in support of graduate education of future scientists. Somewhat more than 75 percent of the salaries of graduate assistants came from research, principally in the state agricultural experiment stations (SAES); contributions from federal agencies also were noted. On the average, about 5 percent of the SAES research funds nationally were used to support graduate research assistants. However, in universities historically prominent in graduate training in agriculture, state agricultural experiment stations often committed two to three times the national average in support of graduate training.

The National Agricultural Research Committee reviewed program plans of its member organizations. Of particular interest were those of the three large USDA agencies: Agricultural Research Service, Economic Research Service, and the Forest Service. Many of the 100 or so state research units also presented their plans.

The National Agricultural Research Committee relied on the Current Research Information System (CRIS) as a mechanism for maintaining communications about agricultural research programs. During the year, CRIS accelerated its ability to handle data entry. It also increased the number of special analyses provided to member organizations and the National Agricultural Research Committee.

In its semiannual meetings, the Committee reviewed legislative and administrative studies in support of various research issues, and also sought comments from staff members of congressional committees with oversight or budgetary responsibilities for research.

National Higher Education Committee

The National Higher Education Committee met twice to discuss the preparation of the 1987 priorities report, the five-year plan update, and the accomplishments report, as well as the concerns of the teaching communities of the agricultural, home economics, veterinary medicine, and forestry sectors.

The committee is compiling all the higher education information submitted for the Joint Council's 5-Year Plan, Priorities Report, and Accomplishments Report into an overall report on higher education. This document, a comprehensive report of higher education's concerns and needs, covers such issues as the enhancement of student enrollment, faculty development, the development and strengthening of curriculums, the provision of state-of-the-art teaching equipment, and the development of an effective information and analysis system. It will be distributed to personnel of the research and extension system, academic administrators, legislators, the media, and others interested in higher education in the food and agricultural sciences.

Other developments in higher education in the food and agricultural sciences include the following:

1. In response to the Secretary's 1984 Challenge Forum, "Investing in Brainpower," a national media campaign is being developed to broaden public understanding of agriculture as a scientific endeavor. Leadership for this effort has come from both industry and universities.

2. Several major U.S. corporations have provided almost $200,000 to support the continued development of teaching materials and faculty training in the areas of (1) agricultural systems, and (2) ethics and public policy issues related to agriculture.

National Extension Committee

The National Extension Committee addressed issues confronting the extension system, contributed to Joint Council reports, and interacted with the Joint Council functional Committees and Regional Councils.

The Committee conducted a systematic review of issues faced by the extension system and selected two for emphasis: (1) Human nutrition and (2) adaptation to private sector sources of (similar) extension services. After considering background papers and reports, the committee made recommendations to the Extension Committee on Organization and Policy for further activity in these areas.

The National Extension Committee and the National Higher Education Committee are considering how they can work together to recruit students for agricultural curriculums. The National Extension Committee discussed the Northeast Regional Council's "Toward 2005" project and set up a continuing liaison with the project.

The Committee successfully proposed the addition of a special category on farm profitability in the Joint Council's next five-year plan. In preparing input for the 1987 Priorities Report, the Committee prepared a list of potential priorities which were then reviewed, added to, and ranked by Extension directors, the National Extension Advisory Council, and the staff of the Extension Service at USDA. The Committee used the resulting national and regional rankings in preparing their input to the Joint Council. Extension accomplishments and staffing projections were developed for use in the other Joint Council reports.

Other Committee activities included a special presentation and tour of the aquaculture industry in New England, reports on the Extension-related Technology Transfer and Research Base studies, and a special review of the Committee's purpose and membership.

Southern Regional Council

In response to a request from the Joint Council, the Southern Regional Council submitted 13 research, teaching, and extension priorities for fiscal year 1987. These 13 were developed from 56 priorities submitted by Council members.

Northeast Regional Council

The major activity of the Council was oversight of the future-oriented project "Toward 2005." In addition to hearing reports from the steering committee and the project's executive director, a press conference was held during the October 1984 Council meeting to serve as a formal kickoff for the project. When the study of the trends and future potential of food and agriculture in the region has been completed, the project will recommend courses of action to make optimal use of the region's resources to meet the food and agricultural needs of the people. While the emphasis is on food and agriculture, social and economic perspectives of the region also will be considered in the analysis and recommendations.

Member organizations of the Council reported activities directed at: (1) recruiting students to ensure an adequate supply of agricultural professionals with Ph.D. degrees, (2) dealing with changing roles, and (3) identifying high-priority issues requiring immediate attention. For example, the Northeast Association of State Departments of Agriculture sponsored a conference in December 1984 that identified three research issues and three administrative issues (legislative or regulatory in nature). As a result, the Council devoted a significant block of time at its May 1985 meeting to two major topics. The first was a

review of a presentation entitled "Issues and Concerns About Higher Education in the Land-Grant University." The second involved discussion of the purpose, mission, and objectives of Cooperative Extension. Both topics generated information that is useful for project "Toward 2005."

Western Regional Council

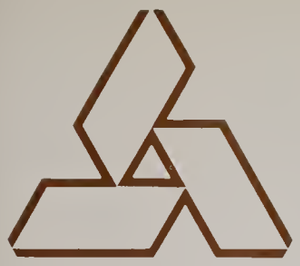
In 1985, the Western Regional Council (WRC) focused its attention on two areas: (1) animal health research, and (2) setting priorities for the future. In November 1984 the WRC discussed "Animal Health Research in American Agricultural Research," a report prepared during a Workshop on Biotechnology for Animal Health Research sponsored by the Association of American Veterinary Medical Colleges and the Council of Deans.

The report pointed out that even with tremendous advances in the area of animal health, diseases still continue to be the single greatest deterrent to efficient livestock production around the world. Even though animal disease losses cost the American farmer $17.5 billion annually, funds are not available for conducting much-needed research. The WRC discussion emphasized that because of the lack of funding, many extremely talented people in the veterinary schools are directing their efforts solely toward the use of animals to solve public health problems.

The Council agreed that the brevity of the report, its concise statement of problems, inclusion of economic data, verification of what needs to be done, and its "readability" make it a valuable document, not only for its content but as a model for similar studies in other problem areas. Therefore, WRC voted to commend the animal health report and the information that it contains to the Joint Council with the suggestion that it be used as a model for conducting similar studies in other problem areas.

With the assistance of subcommittees involving the Western Agricultural Research Committee, the Western Extension Committee, and the Western Higher Education Committee, the Council agreed on priority areas for future attention. As in the past, water adequacy and quality concerns led the list. Issues relating to agricultural profitability and market development were a close second. Jumping to a high priority for the first time was concern for maintenance of numbers of students in agricultural colleges and for the quality of equipment and facilities.

The WRC has been asked by the Western Association of Experiment Station Directors to coordinate the efforts of the Western States' representatives on the Committee for Agricultural Research, Extension, and Teaching (CARET). The WRC will do this in unison with the Western Council of Administrative Heads of Agriculture.



Appendices

Appendix 1

Joint Council Priorities for Research, Extension, and Higher Education and Five-Year Plan Categories

Priorities[1]	Five-Year Plan Categories[2]
	Subject-Matter Categories
Basic Biotechnology Research	Soil, Water, and Air
Sustaining Soil Productivity	Forest, Range, and Wildlife
Scientific Expertise Development	Crop Production and Protection
Water Management	Animal Production and Protection
Plant and Animal Efficiency, Including Protection	Processing, Marketing, and Distribution
Human Nutrition	Agriculture and Resource Policy
Communications Technology/Information Systems	Human Nutrition
Agricultural Policy Analysis/Market Development	Youth, Family, and Consumer Programs
Forest, Range, and Pastureland Productivity Enhancement, Including Multiple Use	Community and Rural Development
	International Science and Education Programs
	Special Categories
	Scientific Expertise in Agriculture
	Biotechnology in Agriculture
	Information Systems and Communication Technology
	Equipment and Facilities

[1]From "Fiscal Year 1986 Priorities for Research, Extension, and Higher Education: A Report to the Secretary of Agriculture." July 31, 1984. 32 pp. (Priorities established by the Joint Council in 1984 for recommended use in budget planning for fiscal year 1986).

[2]From "Five-Year Plan for the Food and Agriculture Sciences: A Report to the Secretary of Agriculture." May 1984. 67 pp.

Appendix 2

The U.S. Food and Agriculture Science and Education System

Cooperative State Institutions:

- Land-grant colleges or universities in each state, as authorized in 1862, plus 16 colleges of 1890 and Tuskegee University, have programs of higher education in the food and agricultural sciences.

- Fifty-eight state agricultural experiment stations (many with networks of substations), plus 16 schools of forestry and certain schools of home economics and veterinary medicine conduct research programs partially supported by federal formula funds. Research investment (all sources) was $1,166 million in fiscal year 1984 involving 7,604 scientist years (SY) of research effort

- Cooperative Extension Services exist in all 50 states plus the District of Columbia and U.S. territories. With total funding at approximately $995 million last year, Coopertive Extension programs involved almost 17,000 professional staff years, plus nearly 4,500 paraprofessional staff years, and significant inputs by over 2.9 million volunteers trained and supervised by professional staff.

USDA Research and Education Agencies:

- The Agricultural Research Service allocated $510.1 million in fiscal year 1985. Research is conducted at 140 locations in the United States and abroad involving 2,666 SY's.

- The Cooperative State Research Service channels most of its funds—$304 million in fiscal year 1985—to the cooperating state research system on a formula basis; it also includes competitive and special research grants and federal administration.

- The Extension Service, with funding of $344 million in fiscal year 1985, channels most of its funds to the Cooperative Extension system; it also includes federal administration.

- The National Agricultural Library, funded at $11.5 million in fiscal year 1985, provides wide-ranging library and technical information services.

- The Economic Research Service, with funding of $46 million for fiscal year 1985, accounts for about 500 SY's of economic and social science research and analysis.

- The Forest Service (research divisions), with funding of $121 million in fiscal year 1985, provided about 800 SY's of research in resource management and utilization plus resource protection functions.

- The Office of Grants and Program Systems during fiscal year 1985 administered $55 million in Competitive Research Grants for several research programs in Science and Education. The Office of Higher Education Programs administered about $8 million for programs designed to strengthen scientific and professional expertise.

Other Colleges and Universities:

- Approximately 200 other state-supported colleges or universities, including 65 with baccalaureate agricultural degrees, conduct programs of higher education, research, and outreach in food and agricultural sciences.

- Other USDA agencies have limited but direct research and education roles:
Office of International Cooperation and Development
Soil Conservation Service
Agricultural Marketing Service
Office of Transportation
Agricultural Cooperative Service
Statistical Reporting Service

Other Federal Agencies:

- At least 14 federal departments, commissions, and independent agencies besides USDA conduct research and education programs closely related to agriculture and forestry or provide funds to support programs in the USDA-state system. Total funding for such programs is estimated at approximately $700 million.

Private Firms:

- Research and development (R&D) are performed by equipment, seed, fertilizer, and other input suppliers; producing, processing, and distributing operations; and specialized private R&D firms. A recent survey published by the Agricultural Research Institute (July 1985) estimates annual research expenditure by private industry at $2.6 billion.

- Field personnel and information specialists employed by vendors of food and agricultural supplies, equipment, and services disseminate technical information to farmers and to processors and distributors of agricultural commodities. Publications related to agriculture, as well as radio and TV, provide timely information which is widely used by those engaged in food and fiber production and processing, and is of interest to many consumers.

- **Other Private Organizations:**

- Foundations or similar organizations facilitate or channel funds to research and/or educational programs in the public

- Associations formed by private firms conduct research and/or educational programs for their members.

Appendix 3

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Appendix 5

Recent National and State Planning Activities in Science and Education

National Planning Activities

Agricultural Research Service, USDA. Agricultural Research Service Program Plan—6-Year Implementation Plan, 1984-1990. 1983. (Dr. T. B. Kinney, Jr., Administrator).

Cooperative State Research Service, USDA. University-based Forestry Research: Unlocking the Future. 1985. National Association of Professional Forestry Schools and Colleges and Cooperative State Research Service, USDA. (Dr. J. C. Lee, President, NAPFSC and Dr. J. P. Jordan, Administrator, CSRS).

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